Claims

1. A device (1) for detecting at least one substance of a fluid (9), having at least one piezo acoustic resonator (2) comprising
   - at least one piezoelectric layer (4),
   - an electrode (5, 6) disposed on the piezoelectric layer (4)
   - at least one further electrode (6, 5) disposed on the piezoelectric layer (4), and
   - a surface section (8) for sorption of the substance of the fluid (9),
   - wherein the piezoelectric layer (4), the electrodes (5, 6) and the surface section (8) are arranged with respect to one another in such a way that an electrical actuation of the electrodes (5, 6) leads to an oscillation of the resonator (2) at a resonance frequency and the resonance frequency is dependent on an amount of the substance sorbed on the surface section (8),
   characterized in that
   - a layer thickness (7) of the piezoelectric layer (4) is chosen from the range of 0.1 µm inclusive to 20 µm inclusive and
   - the resonance frequency of the oscillation is chosen from the range of 500 MHz inclusive to 10 GHz inclusive.

2. The device as claimed in claim 1, wherein the resonator (2) has a lateral extension (11) which is chosen from the range of 20 µm inclusive to 1000 µm inclusive.

3. The device as claimed in claim 1 or 2, wherein the oscillation of the resonator (2) is chosen from the longitudinal oscillation (52) and/or the thickness shear mode oscillation (51) group.

4. The device as claimed in one of the claims 1 to 2, wherein the piezoelectric layer (4) has a piezoelectric material which is chosen from the plumbum zirconate titanate, zinc oxide and/or aluminum nitride group.

5. The device as claimed in one of the claims 1 to 4, wherein the resonator (2) is disposed on a semiconductor substrate (3).

6. The device as claimed in claim 5, wherein at least one device (15) is present to provide acoustic insulation of the resonator (2) and the semiconductor substrate (3).

7. The device as claimed in claim 5 or 6, wherein the surface section (8) for sorption of the substance of the fluid is disposed at a recess (13) of the semiconductor substrate (3).

8. The device as claimed in one of the claims 1 to 7, wherein at least one evaluation device (17, 18) is present for determining the resonance frequency of the resonator (2).

9. The device as claimed in claim 8, wherein the evaluation device is an internal evaluation device (17) disposed in the semiconductor substrate (3).

10. The device as claimed in claim 8, wherein the evaluation device is an external evaluation device disposed outside of the semiconductor substrate (3).

11. The device as claimed in claim 10, wherein at least one device (20) is present for establishing electric contact between the resonator (2) and the external evaluation

device (18), said device being a high frequency substrate chosen from the FR4 substrate and/or LTCC substrate group.

12. The device as claimed in claim 11, wherein the resonator (2) with semiconductor substrate (3) and the high frequency substrate (20) are connected to each other by means of a flip-chip technology.

13. The device as claimed in one of the claims 1 to 11, wherein the surface section (8) for sorption of the substance of the fluid (9) is formed by a chemically sensitive coating (10) of the resonator (2).

14. The device as claimed in claim 13, wherein the resonator (2) has a protective layer (12) and the chemically sensitive coating (10) is applied to the protective layer (12).

15. The device as claimed in one of the claims 1 to 14, wherein a plurality of resonators (2) are combined to form a resonator array (26) and each of the resonators (2) forms an array element (27) of the resonator array (26).

16. The device as claimed in claim 15, wherein each of the resonators (2) in the resonator array (26) serves to detect a specific substance.

17. The device as claimed in claim 15 or 16, wherein a spacing (28) between adjacent array elements (27) is chosen from the range of 50 µm inclusive to 1000 µm inclusive.

18. A method for detecting at least one substance of a fluid using a device according to one of the claims 1 to 17, comprising the following method steps:

a) Bring the fluid and the piezo acoustic resonator into contact in such a way that the substance can be sorbed on the surface section of the resonator,
and

b) Determine a resonance frequency of the resonator, whereby the amount of the substance sorbed on the surface section can be deduced from the resonance frequency.

19. The method as claimed in claim 18, wherein the resonance frequency is determined in the presence of the fluid.

20. The method as claimed in claim 18 or 19, wherein the resonance frequency is determined in the absence of the fluid.

21. The method as claimed in claim 20, wherein a liquid is used as the fluid and after the fluid and the resonator are brought into contact and before the resonance frequency is determined the fluid is removed in such a way that the substance remains sorbed on the surface section of the resonator.

22. A device as claimed in claim 13, wherein the chemically sensitive coating has molecules for detecting the substance.

23. The device as claimed in claim 22, wherein the chemically sensitive coating has an immobilization layer for connecting the resonator and the molecules for detecting the substance.